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The Ohio State University

COMMUNICATION APPLICATIONS OF ADAPTIVE ARRAYS

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20 ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report describes progress under Naval Air Systems Command Contract N00019-79-C-0291 during the third quarterly period. Research on adaptive arrays for communication applications is summarized.

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CONTENTS

I. INTRODUCTION

This report describes progress under NASC Contract N00019-79-C-0291 during the third quarterly period. There are three areas of work, ~~under this contract.~~ The first involves studies on weight jitter and dynamic range for the improved LMS loop. The second is a continuation of research on a reference signal generation technique for FSK signals. The third area involves the preparation of a monograph on adaptive arrays.

II. PROGRESS

(1) The Improved LMS Loop

During the third quarter, simulations have been completed on weight jitter performance for the improved loop[1]. Most of these simulations have involved a loop with RC filtering, instead of the finite time averaging studied originally. Weight variance with this loop has been found to be well-behaved. As signal powers are increased, weight variance approaches a constant value, rather than increasing as in the LMS algorithm.

During this quarter work has also been started to determine the effect of finite component dynamic range on the performance of this loop. To date we have been studying the effect of multiplier saturation in the extra feedback path. If the multiplier in this path saturates, one finds that the time constants become spread again. (The purpose of the improved loop is to prevent time constant spread). Computations are being made of the system eigenvalues under various saturation conditions. The purpose it to determine how much multiplier dynamic range is necessary to keep the time constant spread within certain limits.

(2) Reference Signal Generation with FSK Signals

The development of an adaptive array concept for FSK signals has continued with more work on a computer simulation program. The computer program simulates a two-element LMS array operating with an FSK desired signal and a CW interference signal. The desired signal is Markov coded so that each bit can be predicted at the receiver just before it arrives. A processing loop, modeled in the simulation program, uses the bit predictions and the array output to generate a reference signal.

During the third quarter, work was done to study the effects of bit prediction errors on the system performance. Since the desired signal must convey useful information, bit prediction errors cannot be avoided. Therefore it is important to understand their effects on performance. Analysis of the array output data from the simulations shows that prediction errors modulate the desired signal amplitude with a sawtooth waveform. The frequency and phase of the desired signal, however, are relatively unaffected. Since FSK detection is based on frequency, it is found that prediction errors do not significantly increase the detection error probability of the receiver.

Work on the adaptive array with FSK signals is continuing with additional simulations and study of lockup in the presence of interference. Since the array output is used to form the reference signal, it is difficult to obtain mathematical expressions for lockup criteria. For this reason, simulation results are necessary to find the level of prediction errors that the FSK array can tolerate and still perform acceptably. A technical report on these results is in preparation.

(3) The Adaptive Array Monograph

Work on the monograph is continuing. During this quarter several studies have been done to fill gaps in the available information on adaptive arrays. For example, two papers have been completed that describe the performance of adaptive arrays working with polarized elements. One paper describes the performance of an array of two pairs of crossed dipoles[2], and the other an array of three mutually perpendicular dipoles[3], in each case with arbitrarily polarized desired and interference signals. This material will be submitted for publicaiton shortly and will also be integrated into the monograph.

REFERENCES

1. R. T. Compton, Jr., "An Improved Feedback Loop for Adaptive Arrays," to appear in IEEE Transactions of Aerospace and Electronic Systems, May, 1980.

2. R. T. Compton, Jr., "On the Performance of a Polarization Sensitive Adaptive Array", to be submitted to IEEE Transactions on Antennas and Propagation.

3. R. T. Compton, Jr., "The Tripole Antenna -- An Adaptive Array with Full Polarization Flexibility," to be submitted to IEEE Transactions on Antennas and Propagation.